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Soybeans and Soybean Oilmeal for Pigs

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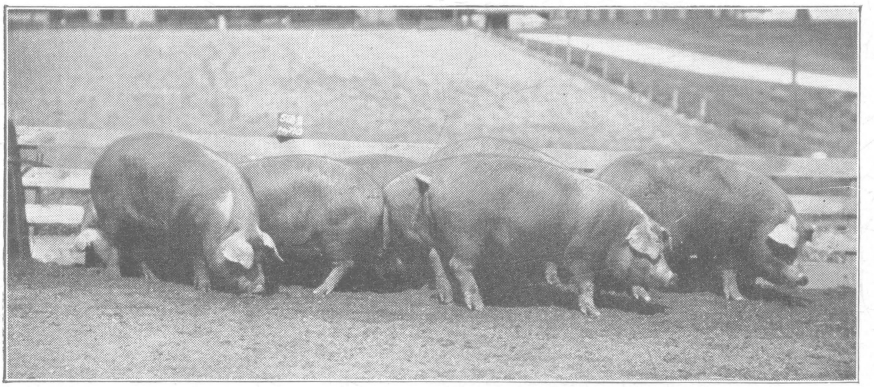
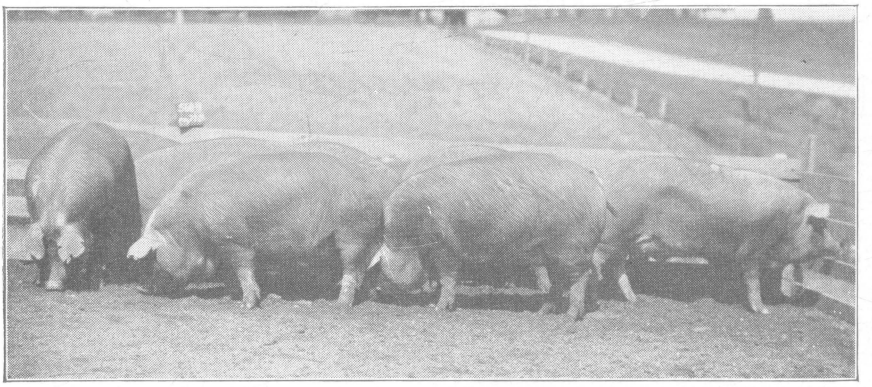


"Vegetarian Pigs"

Corn, soybean oilmeal, linseed meal, ground alfalfa, limestone, 16% superphosphate, and salt

Average daily gain, Nov. 20 to Apr. 9,	1.22	lb.
Feed per 100 lb. gain,	392	lb.



Corn, tankage, linseed meal, ground alfalfa, limestone, and salt

Average daily gain, Nov. 20 to Apr. 9,	1.20	lb.
Feed per 100 lb. gain,	445	lb.

SOYBEANS AND SOYBEAN OILMEAL FOR PIGS

W. L. ROBISON

Soybeans are worthy of attention as a source of protein for use with corn, or other grains, in the feeding of swine. They contain from 33 to 40 percent of protein. Soybeans can be grown successfully under a wide range of conditions, and their production is increasing. A number of experiments have been conducted to determine their worth when fed in various ways and to secure information concerning methods of utilizing them advantageously as a feed for pigs.

That a ration of corn and soybeans gives better results than one of corn alone was shown by an experiment reported in Bulletin 209. In that experiment 90-pound pigs that were fed corn alone, in dry lot, gained 0.57 pound daily a head and required 618 pounds of feed for each 100 pounds of gain produced; while similar pigs fed corn and soybeans gained 1.07 pounds daily and required 342 pounds of corn and 86 pounds of soybeans, or a total of 428 pounds of feed, for each 100 pounds of gain. At a valuation of 1.6 cents a pound for ground corn, that replaced by the ground soybeans would give them a value of $3.08 a bushel.

Inasmuch as corn alone is an inefficient ration, such a comparison gives the supplemental feed an exaggerated value. This is illustrated by the results obtained from feeding tankage with corn in the same experiment. The corn and tankage produced gains at the rate of 1.61 pounds daily on a feed consumption of 309 pounds of corn and 51 pounds of tankage for each 100 pounds of gain. Comparing this ration with corn alone, the corn replaced by the tankage would give tankage a value of $193.88 a ton.

A more nearly accurate estimate of the value of a protein supplement is obtained by determining its worth for replacing some other high protein feed in the ration. Without taking the difference in the rapidity of gains into account and figuring ground corn at 1.6 cents a pound and tankage at $80 a ton, the quantity of these replaced by ground soybeans in this experiment gave soybeans a relative value of $1.05 a bushel.

Table 1 gives the results of an experiment in which soybeans and tankage were compared as supplements to corn for growing and fattening pigs having no forage.

TABLE 1.—Soybeans and Tankage as Supplements to Corn for Pigs in Dry Lot Without Minerals

	Corn Soybeans	Corn Tankage
Number of pigs	6	6
Initial weight per pig, pounds	68.60	67.75
Final weight per pig, pounds	199.10	197.67
Average daily gain, pounds	**.89**	**1.16**
Days required to gain 130 lb.	146	112
Daily feed per pig: (pounds)		
Corn	3.51	4.15
Supplement	.70	.40
Salt	.04	.04
Total	**4.25**	**4.59**
Feed per 100 lb. gain: (pounds)		
Corn	395.59	357.54
Supplement	78.85	34.48
Salt	4.63	3.53
Total	**479.07**	**395.55**
Cost of feed per 100 lb. gain	$8.47	$7.14
Replacement value of soybeans per bu.	.58	....

Corn 84¢, soybeans $1.50 a bu.; tankage $80 a ton; grinding corn 10¢, and soybeans 15¢ a 100 lb.

No minerals other than salt were fed. The pigs were placed on feed at a somewhat lighter weight than those in the experiment referred to above. Soybeans again produced slower and more costly gains than tankage. The pigs given soybeans required five weeks more time to reach an average market weight of 200 pounds than those given tankage, and their feed consumption per unit of gain was 21 percent greater. As determined from the worth of the other feeds replaced, the ground soybeans had a feeding value of only 58 cents a bushel in this test.

MINERALS NEEDED WITH SOYBEANS AND SOYBEAN OILMEAL

When high protein feeds of plant origin, such as soybeans, soybean oilmeal, and linseed meal, are fed along with corn or other grains, additional minerals are needed in the ration. Table 2 gives the average results of two experiments in which rations of corn and soybeans; of corn, soybeans, and minerals; and of corn and tankage were compared for the feeding of pigs on rape pasture. In one of these the minerals consisted of salt and limestone and in the other of salt, limestone, and bone meal. The minerals enabled the pigs to reach an average market weight of 200 pounds four days earlier and saved 24.6 pounds of corn and 1.4 pounds of soybeans for each 100 pounds of gain produced.

Without taking the slightly faster gains into account, the other feeds saved per unit of gain by the ground soybeans gave them a feeding value of $1.63 a bushel when minerals were fed and $1.19 a bushel when no minerals, other than salt, were included in the ration.

TABLE 2.—Soybeans, With and Without Minerals, for Pigs on Pasture

	Corn Soybeans	Corn Soybeans Minerals	Corn Tankage
Number of experiments	2	2	2
Number of pigs	17	17	17
Initial weight per pig, pounds	54.0	54.0	54.1
Final weight per pig, pounds	199.9	200.2†	200.1†
Average daily gain, pounds	**1.23**	**1.27**	**1.30**
Daily feed per pig: (pounds)			
Corn	4.46	4.30	4.59
Supplement	.52	.52	.30
Minerals	.03*	.09	.07‡
Total concentrates	**5.01**	**4.91**	**4.96**
Feed per 100 lb. gain. (pounds)			
Corn	364.09	339.45	353.31
Supplement	42.20	40.84	23.31
Minerals	2.64*	7.18	5.11
Total concentrates	**408.93**	**387.47**	**381.73**
Cost of concentrates per 100 lb. gain	$6.97	$6.66	$6.68
Replacement value of soybeans per bu.	1.19	1.63	.....

*Salt only.
†Two pigs were removed from the lots on each of these rations.
‡Consisted of salt only in one experiment; 26.25 lb. consumed.
Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

Since forage crops are relatively high in ash or minerals, the need for minerals is even greater for winter feeding or for pigs having no green feed than for pigs running on pasture. The results of two experiments in which soybean oilmeal was fed as a supplement to corn, both with and without minerals, to pigs in dry lot are reported in Table 3.

In one of the experiments six of the eight pigs fed no minerals other than salt had developed pronounced symptoms of rickets by the 14th week and the condition of two had necessitated their removal from the lot. Hence, beginning with the 15th week, 3 percent of ground alfalfa was added to the ration.

The pigs given limestone and bone meal in addition to corn, soybean oilmeal, and salt made 0.46 or almost a half pound more gain daily a head and consumed only three-fourths as much feed for each 100 pounds of gain produced. While minerals may not always show up as favorably as they did in these tests there is no question but that they are beneficial for feeding with rations of this type. As reported in Bulletin 349, page 164, minerals also proved helpful in an earlier test with corn and soybean oilmeal.

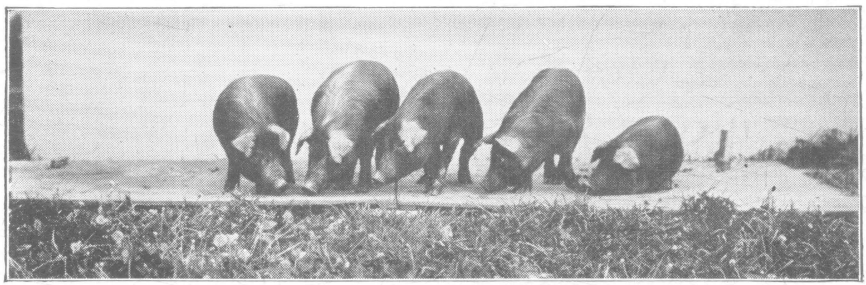


Fig. 1.—Corn, soybean oilmeal, and salt

Initial weight per pig,	43.9 lb.
Average daily gain, Dec. 16 to May 19,	0.49 lb.

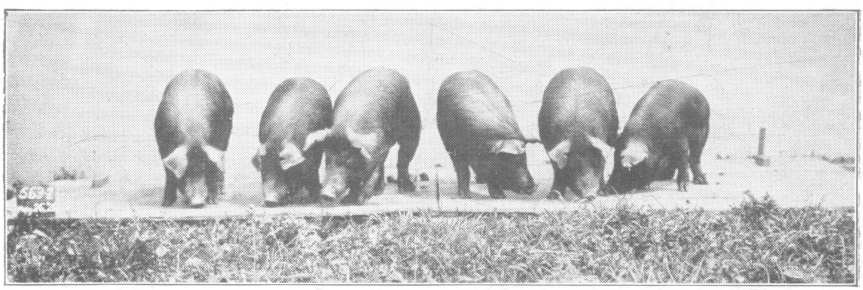


Fig. 2.—Corn, soybean oilmeal, salt, and limestone

Initial weight per pig,	44.4 lb.
Average daily gain, Dec. 16 to May 19,	0.58 lb.

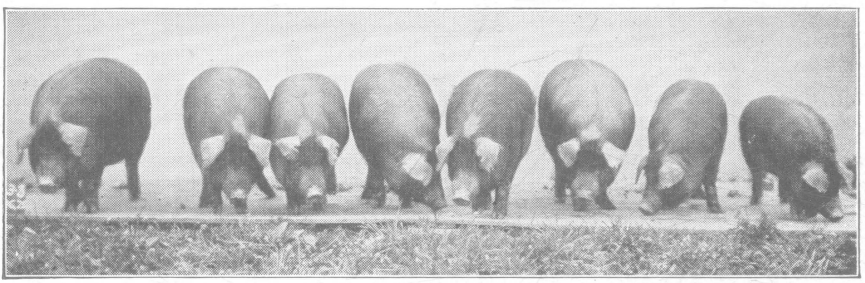


Fig. 3.—Corn, soybean oilmeal, salt, limestone, and bone meal

Initial weight per pig,	44.2 lb.
Average daily gain, Dec. 16 to May 19,	1.16 lb.

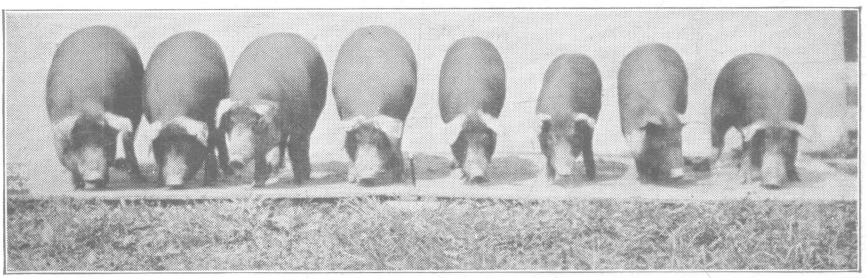


Fig. 4.—Corn, tankage, salt, limestone, and bone meal

Initial weight per pig,	44.2 lb.
Average daily gain, Dec. 16 to May 19,	1.11 lb.

TABLE 3.—Minerals for Feeding With Soybean Oilmeal to Pigs in Dry Lot

	Corn Soybean oilmeal Salt	Corn Soybean oilmeal Minerals	Corn Tankage Minerals
Number of experiments	2	2	2
Number of pigs	15*	15	15
Initial weight per pig, pounds	46.2	46.6	46.3
Final weight per pig, pounds	167.8	203.4	205.8
Average daily gain, pounds	**.69**	**1.15**	**1.06**
Daily feed per pig: (pounds)			
Corn	2.80	3.51	4.01
Supplement	.39	.49	.38
Minerals	.03†	.11	.03§
Ground alfalfa	.01‡		
Total	**3.23**	**4.11**	**4.42**
Feed per 100 lb. gain: (pounds)			
Corn	409.09	304.48	378.07
Supplement	56.60	42.55	35.45
Minerals	3.82	9.74	3.22
Ground alfalfa	1.14		
Total	**470.65**	**356.77**	**416.74**
Cost of feed per 100 lb. gain	$8.30	$6.34	$7.53

*Three pigs which developed rickets were taken out of the lot in one experiment.
†Salt.
‡In one experiment, beginning with the fifteenth week, or after six out of eight pigs in the lot had become crampy or lame, 3 percent of ground alfalfa was included in the ration.
§Salt in only one experiment and salt 1, limestone 2, bone meal 2, in the other.
Corn 84¢ a bu.; soybean oilmeal $60, tankage $80, minerals $40, ground alfalfa $30 a ton; grinding corn 10¢ a 100 lb.

SOYBEANS UNSATISFACTORY FOR YOUNG PIGS WITHOUT FORAGE

Summaries of experiments comparing soybeans and tankage as supplements to corn for pigs in dry lot and on pasture, when minerals were fed, are given in Table 4.

The data show that soybeans have a relatively low value for supplementing corn for pigs in dry lot, even tho minerals are included in the ration. According to the relative rates of growth two months more time would have been required by the pigs given soybeans than by those given tankage to reach an average weight of 200 pounds. Aside from the slower gains, soybeans, after having been ground, had a comparative feeding value of only 56 cents a bushel. Judging from these data soybeans should not be fed to young pigs, particularly if they are not on forage.

The value of soybeans as compared with that of tankage was relatively higher for pigs on forage than for those in dry lot. With the pigs running on good pasture, those given soybeans required only 15 days more time than those given tankage to fit them for market. For dry lot feeding the soybeans were worth only 23 percent as much as an equal weight of tankage, but for feeding on pasture they were worth 51 percent as much.

TABLE 4.—Summaries of Experiments Comparing Soybeans and Tankage for Pigs When Minerals Were Fed

	In dry lot*		On forage†	
	Corn Soybeans Minerals	Corn Tankage Minerals	Corn Soybeans Minerals	Corn Tankage Minerals
Number of trials	6	6	4	4
Number of pigs	39	39	36	36
Initial weight per pig, pounds	48.73	48.70	53.94	54.43
Final weight per pig, pounds	174.54	205.65	209.30	218.46
Average daily gain, pounds	**.74**	**1.06**	**1.14**	**1.30**
Days required to gain 150 lb.	203	141	131	116
Daily feed per pig: (pounds)				
Corn	2.91	3.80	4.05	4.68
Supplement	.46	.34	.55	.32
Ground alfalfa	.04	.04—	.....	.....
Minerals	.08	.04+	.10	.06
Total	**3.49**	**4.22**	**4.70**	**5.06**
Feed per 100 lb. gain: (pounds)				
Corn	393.37	357.86	354.99	360.70
Supplement	62.12	32.49	48.39	24.23
Ground alfalfa	4.98	3.50	.....	.....
Minerals	10.84	4.16	8.46	4.86
Total	**471.31**	**398.01**	**411.84**	**389.79**
Cost of feed per 100 lb. gain	$8.23	$7.16	$7.13	$6.84
Replacement value of soybeans per bu.	.56	.....	1.22	.....

*In the dry lot experiments four pigs were removed from the soybean lots and three from the tankage lots.

†In the tests on forage six pigs were removed from the soybean lots and two from the tankage lots.

Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

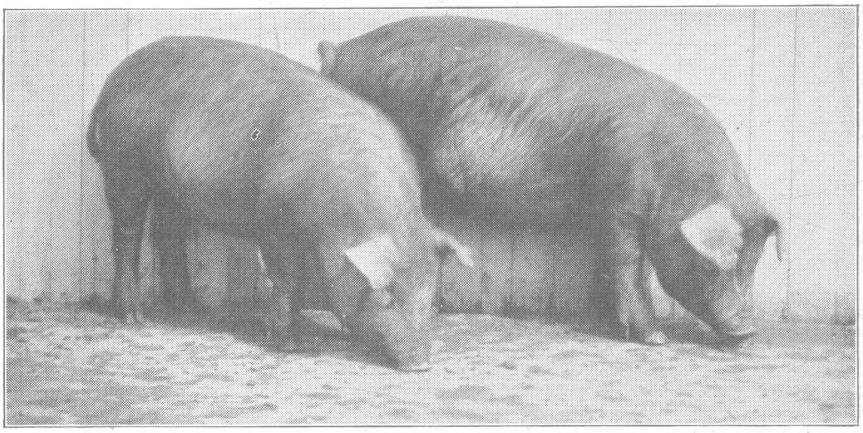


Fig. 5.—The pig at the left was fed corn, ground soybeans, and minerals. From Dec. 11 to Apr. 29 it gained at the rate of 0.84 lb. a day. The one at the right was fed corn, tankage, and minerals. From Dec. 11 to Apr. 29 it gained at the rate of 1.09 lb. a day.

Table 5 gives the results of three tests in which soybeans were fed with minerals and seven in which they were fed without minerals, under dry lot conditions, to shotes averaging 120 pounds in weight when placed on feed.

TABLE 5.—Comparison of Soybeans and Tankage as Supplements to Corn for Shotes in Dry Lot

	Without minerals*		With minerals†	
	Corn Soybeans	Corn Tankage	Corn Soybeans	Corn Tankage
Number of trials	7	7	3	3
Number of pigs	34	35	18	18
Initial weight per pig, pounds	123.47	124.00	121.0	121.32
Final weight per pig, pounds	221.44	243.86	225.5	225.36
Average daily gain, pounds	**1.38**	**1.68**	**1.44**	**1.57**
Days required to gain 125 lb.	90	74	87	80
Daily feed per pig: (pounds)				
Corn	4.91	6.01	4.87	5.94
Supplement	.97	.65	.89	.47
Minerals	.....	.....	.13	.07
Total	**5.88**	**6.66**	**5.89**	**6.48**
Feed per 100 lb. gain: (pounds)				
Corn	355.60	357.43	337.11	377.45
Supplement	69.90	38.61	61.76	29.79
Minerals	.....	.....	8.52	4.29
Total	**425.50**	**396.04**	**407.39**	**411.53**
Cost of feed per 100 lb. gain	$8.03	$7.26	$7.15	$7.32
Replacement value of soybeans per bu.	1.35	.....	1.70	.....

*In one of the experiments without minerals a shote was removed from the soybean lot.

†Except in two of the mineral experiments, in which shelled corn and whole soybeans were fed, the corn and soybeans were ground.

Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

Shelled corn, whole soybeans, and minerals were self-fed separately, or free-choice, in two of the experiments reported in the summary. These included five groups of pigs, each of which was fed a different variety of soybeans. The data given in the summary are for the soybean groups making the most rapid gains and the greatest amount of gain from a given quantity of feed in each experiment. In one of the experiments 1 pound of beans to every 2.76 pounds of corn was consumed; in the other only 1 pound to every 17.78 pounds of corn. The hand-fed shotes in the third experiment were given a mixed ration containing an average of 1 pound of beans to every 5.48 pounds of corn. The results of this experiment are presented separately in Table 6.

When minerals were fed, the shotes getting soybeans gained 91.7 percent as rapidly as those getting tankage. Their feed requirement per unit of gain was slightly lower than that of the tankage-fed shotes. Consequently, at the prices used, their gains were less costly. The soybeans were worth $1.70 a bushel when fed in this way along with corn and minerals to shotes in dry lot.

While the rations with and without minerals were not directly compared, the relative results from tankage and soybeans, with and without minerals, provide further evidence of the need of minerals when soybeans are fed. With no minerals in the ration the shotes given soybeans gained 82.1 percent as rapidly as those given tankage and consumed 7.69 percent more feed per unit of gain. Under these conditions the soybeans were worth $1.35 a bushel.

SOYBEANS WORTH MORE FOR SHOTES THAN FOR YOUNG PIGS

That soybeans have a higher value for shotes than for younger pigs was demonstrated by the differences obtained in the experiment reported in Table 6. Soybeans and tankage were used as supplements to corn and minerals for feeding both pigs and shotes of similar breeding running on clover pasture, and averaging approximately 50 and 130 pounds in weight, respectively, when placed on feed. As determined from the quantities of feed consumed for each 100 pounds of gain produced and the amounts of tankage and other feeds replaced by the soybeans, the ground soybeans were worth $1.26 a bushel when fed to the pigs and $1.49 when fed to the older shotes.

TABLE 6.—Ground Soybeans* and Tankage for Pigs of Different Ages and for Pasture and Dry Lot Feeding

	Corn Soybeans Minerals	Corn Tankage Minerals	Corn Soybeans Minerals	Corn Tankage Minerals	Corn Soybeans Minerals	Corn Tankage Minerals
Kind of pigs	Shotes	Shotes	Shotes†	Shotes	Weanling†	Weanling
Kind of forage	None	None	Clover	Clover	Clover	Clover
Number of pigs	8	8	8	8	10	10
Initial weight per pig, lb.	133.19	133.94	134.29	132.87	48.5	49.05
Final weight per pig, lb.	252.88	254.37	250.93	253.69	217.75	250.1
Average daily gain: lb.	**1.42**	**1.72**	**1.71**	**1.73**	**.92**	**1.20**
Days required to gain 125 lb.‡	88	73	73	72	190	146
Daily feed per pig: (lb.)						
Corn	4.71	6.02	5.89	6.30	3.47	4.67
Supplement	.86	.46	.76	.36	.54	.33
Minerals	.17	.10	.14	.07	.08	.05
Total	**5.74**	**6.58**	**6.79**	**6.73**	**4.09**	**5.05**
Feed per 100 lb. gain: (lb.)						
Corn	330.34	349.90	344.34	365.17	376.17	390.64
Supplement	60.29	26.92	44.52	21.00	58.48	27.25
Minerals	12.08	5.74	7.93	3.90	8.87	4.22
Total	**402.71**	**382.56**	**396.79**	**390.07**	**443.52**	**422.11**
Cost of feed per 100 lb. gain§	$7.12	$6.79	$6.85	$6.76	$7.75	$7.42
Replacement value of soybeans per bu.	1.26	.....	1.49	.....	1.26	.....

*The corn and soybeans were ground and the feeds mixed and self-fed.
†One shote and two pigs were removed from the lots getting soybeans on clover pasture.
‡Days required to gain 175 lb. or to reach an average weight of 225 lb.
§Not including pasture.
Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

There was a difference of only nine-tenths of 1 percent in the rate of growth between the shotes fed soybeans and those fed tankage; for the younger pigs the difference amounted to 22.9 percent in favor of tankage.

While they were not obtained from direct comparison the data presented in Tables 4 and 5 provide further evidence of the greater worth of soybeans for well-grown shotes than for younger pigs. In these tests the soybeans were worth 56 cents a bushel when fed to pigs averaging 49 pounds, and $1.70 a bushel when fed to shotes averaging 121 pounds at the beginning of the experiments.

PASTURE INCREASES THE FEEDING VALUE OF SOYBEANS

As mentioned in the discussion of Table 4, summaries of dry lot and pasture experiments which were not directly comparable indicated soybeans to have a higher feeding value for pigs on pasture than for those in dry lot. In the experiment reported in Table 6 soybeans and tankage were also compared as supplements to corn and minerals for shotes in dry lot, as well as for the similar ones running on clover pasture. On forage the shotes given soybeans gained 99.1 percent as rapidly as those given tankage. In the absence of forage soybeans produced gains only 82.8 percent as rapidly as tankage.

Under dry lot conditions 5.3 percent more feed per unit of gain was required by the shotes fed soybeans than by those fed tankage. On forage only 1.7 percent more feed per unit of gain was consumed by the shotes given soybeans than by those given tankage. With other feeds at the prices given, ground soybeans were worth $1.26 a bushel when fed to shotes in dry lot and $1.49 when fed to similar shotes on forage. An even greater difference in value for feeding under the two conditions would be expected with younger pigs.

VARIETIES OF SOYBEANS DIFFER IN PALATABILITY AND FEEDING VALUE

Different varieties of soybeans vary widely in their oil and protein content as well as in color and size. Even the same variety differs more or less as a result of variations in such factors as soil and seasonal conditions, cultural methods, and source of seed. Table 7 gives the results of experiments in which two rations containing different varieties of soybeans and a third one containing tankage were compared. The pigs, averaging slightly less than 50 pounds when placed on feed, were kept indoors during the tests. In

both tests the corn and soybeans were ground and these and minerals mixed in definite proportions. A larger percentage of soybeans was used during the first part of the feeding period than later when the pigs were heavier. Three percent of ground alfalfa was included in the rations in the second experiment. The pigs were self-fed in the first and hand-fed in the second experiment.

TABLE 7.—Comparison of Varieties of Soybeans as Supplements to Corn for Pigs in Dry Lot

	Experiment 1*			Experiment 2*		
	Corn Manchu soybeans Minerals	Corn Ebony soybeans Minerals	Corn Tankage Minerals	Corn Manchu soybeans Minerals	Corn Midwest soybeans Minerals	Corn Tankage Minerals
Number of pigs	8	8	8	5	5	5
Initial weight per pig, lb.	46.75	46.5	46.6	48.5	48.6	49.4
Final weight per pig, lb.	79.5	118.8	231.6	154.75	152.7	190.8
Average daily gain, lb.	.21	.41	1.14	.53	.61	.61
Daily feed per pig: (lb.)						
Corn	1.49	1.85	3.92	1.82	1.99	2.21
Supplement	.29	.31	.37	.42	.44	.20
Ground alfalfa	.....	.....	.....	.07	.08	.08
Minerals	.05	.05	.05	.06	.06	.04
Total	1.83	2.21	4.34	2.37	2.57	2.53
Feed per 100 lb. gain: (lb.)						
Corn	697.60	449.24	343.10	342.02	323.75	360.26
Supplement	136.95	75.06	32.78	79.22	72.40	33.47
Ground alfalfa	.....	.....	.....	13.37	12.57	12.37
Minerals	21.40	12.74	4.66	11.15	10.48	6.18
Total	855.95	537.04	380.54	445.76	419.20	412.28
Cost of feed per 100 lb. gain	$15.22	$9.43	$6.89	$8.00	$7.50	$7.41
Replacement value of soybeans per bu.	—2.06	—.44	.....	1.16	1.52	.....

*In Experiment 1, one pig was removed from the Manchu soybean lot, two from the Ebony soybean lot, and one from the tankage lot, during the course of the trial. In Experiment 2, one pig was taken out of the Manchu soybean lot and two out of the tankage lot.

Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

Manchu and Ebony soybeans, a yellow and a black variety, were compared in the first experiment. Both gave exceptionally poor results, but those from the Ebony were not as poor as those from the Manchu.

Manchu and Midwest, two yellow varieties, were compared in the second experiment. The pigs getting Manchu soybeans gained more slowly and consumed 27 pounds more feed for each 100 pounds of gain than did those getting the Midwest. Not considering the difference in the rate of growth, but only the amounts of the other feeds replaced by the soybeans, per unit of gain the Manchu beans were worth $1.16 a bushel for feeding in this way and the Midwest $1.52, or 36 cents more a bushel.

Five varieties of soybeans, Wilson, Ebony, Hamilton, Manchu, and Midwest, were compared for self-feeding free-choice to different groups of shotes in dry lot in the experiment reported in Table 8. Shelled corn, whole soybeans, and minerals were fed. A sixth group of shotes was given access to all five varieties kept before them in separate compartments of self-feeders. To avoid the heavy consumption of a variety merely because it might happen to be in a particular location, each variety for this lot was changed to a different compartment each week, and thus completely rotated every five weeks. A seventh or check group was given tankage as a supplement.

TABLE 8.—Comparison of Varieties of Soybeans as Supplements to Corn for Shotes in Dry Lot. Shelled Corn, Whole Soybeans, and Minerals Self-Fed Separately

December 14, 1926 to February 22, 1927	Shelled corn **Wilson** soybeans Minerals	Shelled corn **Ebony** soybeans Minerals	Shelled corn **Hamilton** soybeans Minerals	Shelled corn **Manchu** soybeans Minerals	Shelled corn **Midwest** soybeans Minerals	Shelled corn **5 varieties** of soybeans Minerals	Shelled corn Tankage Minerals
Ratio of supplement to corn consumed	1:4.0	1:4.7	1:3.3	1:4.7	1:2.8	1:3.1	1:7.7
Number of pigs	5	5	5	5	5	5	5
Initial weight per pig, lb.	104.9	104.1	105.6	104.9	104.1	99.9	101.7
Final weight per pig, lb.	177.9	184.9	185.4	192.9	190.3	176.9	180.9
Average daily gain, lb.	**1.04**	**1.15**	**1.14**	**1.26**	**1.23**	**1.10**	**1.13**
Daily feed per pig: (lb.)							
Corn	3.77	4.24	3.74	4.15	3.59	3.55	4.42
Supplement	.95	.91	1.13*	.88	1.30	1.15†	.58
Minerals	.06	.07	.06	.07	.08	.06	.04
Total	**4.78**	**5.22**	**4.93**	**5.10**	**4.97**	**4.76**	**5.04**
Feed per 100 lb. gain: (lb.)							
Corn	361.64	367.21	327.82	329.77	291.88	322.86	391.16
Supplement	91.10	78.71	99.07	70.23	105.91	104.81	51.14
Minerals	5.62	5.94	5.77	5.52	6.15	5.58	3.53
Total	**458.36**	**451.86**	**432.66**	**405.52**	**403.94**	**433.25**	**445.83**
Cost of feed per 100 lb. gain	$7.81	$7.59	$7.51	$6.81	$7.15	$7.57	$7.98
Replacement value of soybeans per bu.	1.61	1.80	1.79	2.50	1.97	1.68	.....

*The supply of Hamilton soybeans was exhausted Jan. 13 and 29 days elapsed before a new supply could be located and secured. Mixed beans and Ito San were fed in the meantime. While they had them the pigs ate 1.16 pounds of Hamilton soybeans daily a head.

†The total of the five varieties which were self-fed separately and rotated was made up of Wilson 34 lb., Ebony 43 lb., Hamilton 46 lb., Manchu 94 lb., and Midwest 186.5 lb. No Hamilton beans were available from Jan. 22 to Feb. 11. The daily consumption of each variety as named was 0.10, 0.12, 0.18, 0.27, and 0.53 lb., respectively.

Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton.

The shotes used were purchased shortly before the beginning of the test, and, altho it was not known at the time, it was learned afterward that they had previously been running on a field of standing corn containing soybeans. During the experiment they were kept in outside pens and were sheltered in movable houses. The feeders were placed out of doors. All of the lots ate more beans than was anticipated.

The Hamilton soybeans on hand were exhausted after the first 30 days of the test. Difficulty was experienced in locating additional beans of this variety. By the time they were secured 29 days had elapsed since the original supply had been consumed. In the meantime mixed beans, which contained some Hamiltons, but were of rather poor quality, as well as a small quantity of Ito San beans, were fed. The Hamilton compartment of the feeder for the shotes which were to have received all five varieties was merely left empty during this time. It was necessary to purchase additional supplies of Wilson and Ebony soybeans, but no great difficulty was experienced in obtaining these, and the pigs had access to them at all times.

As judged by the percentages contained in the rations consumed by the groups getting a single variety, the soybeans ranked in the following order with reference to palatableness: (1) Midwest, (2) Hamilton, (3) Ebony, (4) Wilson, and (5) Manchu.

TABLE 9.—Amounts of Different Varieties of Soybeans Taken by Self-Fed Pigs

Two-week period	Variety			
	Wilson	Ebony	Manchu	Midwest
	Lb.	*Lb.*	*Lb.*	*Lb.*
First	11.0	14	14.8	12.0
Second	9.2	5	20.0	28.4
Third	10.3	4	29.2	28.6
Fourth	2.5	10	27.0	48.5
Fifth	1.0	10	3.0	69.0
Total	34.0	43	94.0	186.5

Some interesting data are provided by the lot which had access to the different varieties. Table 9 gives the quantities of the four varieties available thruout the test that were consumed in the five bi-weekly periods of the experiment. During the first two weeks the amounts eaten ranged from 11 to 14.8 pounds. During the next two-week period there was more variation, and in the last two weeks 69 pounds of Midwest, 10 of Ebony, 3 of Manchu, and 1 of Wilson were taken. The shotes apparently acquired a taste for Midwest soybeans and hunted for them regardless of their location in the feeders. The consumption of this lot would rank the palatability of the four varieties in the following order: (1) Midwest, (2) Manchu, (3) Ebony, and (4) Wilson.

Analyses of the different varieties were made by the Nutrition Division of the Department of Animal Industry. The Wilson, Ebony, Hamilton, Manchu, and Midwest contained 39.2, 42.8, 34.6,

41.2, and 35.1 percent of protein, respectively. The ether extract or oil content of the varieties as named was 17.1, 16.8, 21.2, 20.2, and 20.2 percent. Nothing was observed in the analyses to suggest why one variety should prove more palatable than another.

A similar experiment in which whole Virginia, Ebony, Laredo, Midwest, and Manchu soybeans were compared for self-feeding free-choice, along with shelled corn and minerals to shotes confined indoors, is reported in Table 10.

TABLE 10.—Comparison of Varieties of Soybeans as Supplements to Corn for Shotes in Dry Lot* II

Oct. 24 to Dec. 19, 1928	Shelled corn Virginia soybeans Minerals	Shelled corn Ebony soybeans Minerals	Shelled corn Laredo soybeans Minerals	Shelled corn Midwest soybeans Minerals	Shelled corn Manchu soybeans Minerals	Shelled corn 5 varieties of soybeans Minerals	Shelled corn Tankage Minerals
Ratio of supplement to corn consumed	1:33.8	1:30.2	1:27.6	1:30.2	1:17.8	1:14.6	1:22.4
Number of pigs	5	5	5	5	5	5	5
Initial weight per pig, lb.	122.9	122.1	122.0	122.0	121.8	120.9	120.8
Final weight per pig, lb.	221.2	207.1	224.0	208.6	229.9	213.0	223.4
Average daily gain, lb.	1.76	1.52	1.82	1.55	1.93	1.65	1.83
Daily feed per pig: (lb.)							
Corn	7.61	6.85	7.39	7.02	7.30	6.66	7.67
Supplement	.23	.23	.27	.23	.41	.46	.34
Minerals	.05	.04	.05	.08	.09	.09	.04
Total	7.89	7.12	7.71	7.33	7.80	7.21	8.05
Feed per 100 lb. gain: (lb.)							
Corn	433.57	451.53	405.82	454.22	378.38	404.96	418.58
Supplement	12.82	14.94	14.71	15.02	21.28	27.68	18.71
Minerals	3.05	2.59	2.65	4.85	4.72	5.64	2.14
Total	449.44	469.06	423.18	474.09	404.38	438.28	439.43
Cost of feed per 100 lb. gain	$6.89	$7.20	$6.51	7.29	$6.30	$6.88	$7.07
Replacement value of soybeans per bu.	2.36	.98	3.79	.64†	3.66	1.03	.....

*Before the close of the experiment several of the pigs became stiff or crampy and either lost in weight or made poor gains. This indicates that they failed to take a sufficient quantity of minerals or else that the ration was deficient in vitamin D, the anti-rachitic vitamin. Three pigs in the lot having Ebony soybeans became crampy. During the first six weeks this lot gained 92 percent as much as the lot getting tankage, but during the last two weeks they gained only 37 percent as much.

†During the last four weeks, or the time Midwest soybeans of good quality were fed, they had a replacement value of $4.20 a bushel.

Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton.

Virginia soybeans are brown in color, while the Ebony and Laredo are black, and the Manchu and Midwest are yellow. The Laredo and Midwest usually have a relatively low, and the Manchu and Ebony a high, oil content.

The pigs used were purebred Hampshires, half of which were purchased from a breeder in the state and half from the Paulding County Experiment Farm. They had received no soybeans previous to the beginning of the experiment, and averaged 122 pounds in weight when placed on feed.

None of the varieties of soybeans fed proved palatable to the pigs in this test. To provide a nutritive ratio of 1:7, as is recommended by feeding standards for shotes over 150 pounds in weight, 1 pound of beans to every 7.2 pounds of corn is needed. The group that took the largest percentage of beans in this experiment ate only about half enough to balance the corn, or an average of only 1 pound to every 14.6 pounds of corn.

In spite of their low soybean consumption the shotes made fairly rapid and economical gains during the eight weeks they were on the test. Under the conditions of the experiment even shotes of this age would probably have made a poorer showing if the test had been continued for a much longer time. This is indicated by the fact that some of the pigs ceased to gain as rapidly and became somewhat stiff and crampy toward the close of the experiment.

The difference in the feeding value of some of the varieties of beans possibly was influenced as much by one or more of the pigs in the lot becoming crampy as by the variety of soybeans fed. Each of the lots receiving Virginia and Ebony soybeans contained one or more crampy pigs.

The Midwest soybeans used during the first half of the experiment were somewhat musty or mouldy and were of rather poor quality. After the fourth week Midwest beans of good quality were secured and fed. The pigs getting the low grade Midwest beans took a smaller quantity for the time than those getting any of the other varieties. By the close of the experiment after the beans of better quality were substituted for the poor ones the lot getting Midwest had taken more than any other lot except the one fed the Manchu beans.

During the first four weeks of the experiment the group of pigs having access to the five varieties consumed 36.5 pounds of Manchu and only 3 pounds of the Midwest beans. For the last two weeks, or after the low-grade Midwest beans had been replaced with other beans of the same variety but of better quality, and the pigs had become accustomed to the change, they consumed 1 pound of Manchu soybeans and 12.5 pounds of Midwest. A larger amount of beans of the Midwest than of any of the other varieties was taken during this period.

Varieties of soybeans apparently differ somewhat in their palatability and feeding value. No variety was tried, however, which, even after the pigs had become accustomed to its taste, was eaten readily by all of the lots to which it was self-fed free-choice.

Soybeans that have become more or less musty as a result of carrying too much moisture when placed in storage are not palatable to pigs. While the hypothesis has not been verified, possibly the oil in soybeans carried thru the summer from one season to the next or stored at high temperatures tends to become rancid. If so, palatableness would be expected to decrease with storage.

GRINDING SOYBEANS FOR SHOTES APPARENTLY UNNECESSARY

Whole and ground soybeans were compared in a dry lot experiment in which shotes averaging 120 pounds in weight at the beginning of the test were used. The rations also included shelled corn and minerals, and the feeds were kept before the animals in separate compartments of self-feeders, or self-fed free-choice. Manchu soybeans were fed. A slightly smaller proportion of the whole beans than of the ground beans was consumed. The group of shotes having access to the whole beans, however, made both faster and greater gains from a given amount of feed than the group to which the ground beans were fed.

TABLE 11.—Whole and Ground Soybeans* for Self-Feeding Free-Choice With Corn and Minerals to Shotes in Dry Lot

October 24 to December 19, 1928	Shelled corn **Whole soybeans** Minerals	Shelled corn **Ground soybeans** Minerals	Shelled corn Tankage Minerals
Ratio of supplement to corn consumed	1:17.8	1:15.0	1:22.4
Number of pigs	5	5	5
Initial weight per pig, pounds	121.8	118.4	120.8
Final weight per pig, pounds	229.9	216.9	223.4
Average daily gain, pounds	**1.93**	**1.76**	**1.83**
Daily feed per pig: (pounds)			
Corn	7.30	6.86	7.67
Supplement	.41	.46	.34
Minerals	.09	.06	.04
Total	**7.80**	**7.38**	**8.05**
Feed per 100 lb. gain: (pounds)			
Corn	378.38	389.85	418.58
Supplement	21.28	25.99	18.71
Minerals	4.72	3.65	2.14
Total	**404.38**	**419.49**	**439.43**
Cost of feed per 100 lb. gain	$6.30	$6.61	$7.07
Replacement value of soybeans per bu.	3.66	2.65	.....

*Soybeans of the Manchu variety were fed.
Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton; grinding soybeans 15¢ a 100 lb.

A second comparison of whole and ground soybeans was made in a more recent experiment, which is reported in Table 12. The pigs used in the test had an average initial weight of 110 pounds, but were only 120 days old and rather fat when started on the experiment. Their response to the various rations was more nearly

TABLE 12.—Effect of Variety, of Other Protein, of Grinding, and of Cooking on the Feeding Value of Soybeans*

Protein supplements ☞	Tankage	Cooked Manchu soybeans	Ground Manchu soybeans Cottonseed meal	Ground Manchu soybeans	Ground Manchu soybeans	Ground Midwest soybeans	Whole Midwest soybeans
Basal ration ☞	Corn, ground alfalfa, minerals						
Ratio of soybeans to corn consumed	.....	1:6.1	1:6	1:6	1:12	1:6	1:8.8
Number of pigs	5	5	5	5†	5	5†	5†
Initial weight per pig, pounds	109.9	110.0	109.1	109.2	109.9	110.1	109.4
Final weight per pig, pounds	218.6	223.6	225.2	222.6	194.4	224.2	221.6
Average daily gain, pounds	**1.29**	**1.35**	**1.16**	**.94**	**.80**	**1.09**	**1.15**
Days required to gain 115 lb.	89	85	99	122	143	106	100
Daily feed per pig: (pounds)							
Ground corn	5.30	4.84	4.70	4.44	4.67	4.72	5.13
Tankage or cottonseed meal	.39	.....	.30	.....	.....	.....	.....
Soybeans	.....	.80	.78	.74	.39	.79	.58
Ground alfalfa	.18	.20	.18	.16	.16	.17	.19
Minerals	.07	.16	.15	.14	.15	.15	.16
Total	**5.94**	**6.00**	**6.11**	**5.48**	**5.37**	**5.83**	**6.06**
Feed per 100 lb. gain: (pounds)							
Ground corn	409.29	358.30	404.81	472.24	580.69	434.02	447.58
Tankage or cottonseed meal	30.35	.....	25.83	.....	.....	.....	.....
Soybeans	.....	59.16	67.47	78.71	48.39	72.34	50.87
Ground alfalfa	13.80	14.62	15.81	17.49	20.02	16.07	16.58
Minerals	5.52	11.93	13.18	14.58	18.36	13.40	13.81
Total	**458.96**	**444.01**	**527.10**	**583.02**	**667.46**	**535.83**	**528.84**
Cost of feed per 100 lb. gain	$8.08	$8.26	$9.39	$10.20	$11.24	$9.37	$8.96
Replacement value of soybeans per bu.	.....	1.92	.43	—.02	—2.33	.52	.46
Grading of carcasses:‡	3H, 1MH	1H, 1MH, 1MS, 1S	2H, 2MH, 1MS	2MS, 2S	1H, 1MH, 1MS, 2S	3MH, 1MS	2H, 1MS, 1S
Average refractive index of back fat§	1.4595	1.4607	1.4608	1.4611	1.4604	1.4613	1.4603
Refractive index grading: distribution	3H, 1MH	1H, 1MH, 1MS, 1O	2MH, 3S	1MH, 1MS, 1S, 1O	2H, 1MH, 2O	1H, 1S, 2O	2H, 1MS, 1O
average	Hard	Soft	Soft	Soft	Medium soft	Soft	Medium soft

*The corn was ground and, with the exception of the whole and of the cooked soybeans, the feeds were mixed in definite proportions, and the mixtures self-fed. Approximately 2.5 percent of minerals and 3 percent of alfalfa were included in the soybean rations.

An attempt was made to mix the whole beans with the other feed in the proportion of 1 part to 6 of corn, but the pigs left the beans; so it was necessary to place them in a separate compartment of the feeder and self-feed them, free-choice.

†During the experiment a pig was removed from each of Lots 4, 6, and 7.

‡H=hard; MH=medium hard; MS=medium soft; S=soft; O=oily. The carcasses were graded by Dr. H. K. Walter of the U. S. D. A., Bureau of Animal Industry, who served on the grading committee in the cooperative soft-pork investigations for six years.

§The refractive indexes were determined by Prof. F. H. Helmreich, Dept. of Animal Husbandry, Ohio State University.

Corn 84¢, soybeans $1.50 a bu.; tankage $80, cottonseed meal $48, ground alfalfa $30, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.; cooking soybeans 1¢ a lb.

like that of younger pigs than that of thin older shotes with well developed frames. The pigs were confined indoors during the experiment. Self-feeding was practiced, and small amounts of minerals and alfalfa were included in the rations.

The ground soybeans were mixed with the other feeds at the rate of 1 pound to every 6 pounds of corn. An attempt was made to mix the whole beans with the other feeds in the same proportions so that the only difference in the two rations would be that the beans were ground in one but whole in the other. Feeding the beans whole, however, made it possible for the pigs to sort them out and leave them. For this reason the whole beans were self-fed free-choice, that is they were kept in one compartment and the mixture of ground corn, ground alfalfa, and minerals in the other compartments of the self-feeder. Midwest soybeans were used in the comparison, and the pigs learned to eat them readily before the close of the experiment. They took an average of 1 pound of beans to every 8.8 pounds of corn.

In spite of the somewhat smaller percentage of soybeans consumed, the pigs having access to the whole beans made slightly faster gains and a trifle larger amount of gain from a given quantity of feed than those fed the ground soybeans. The replacement value of the ground beans was 6 cents more than of the whole beans per bushel. Apparently, if pigs eat enough soybeans to balance the ration fairly well little is to be gained by grinding. Grinding the feeds, of course, would make it possible to mix them and thus force the pigs to take more soybeans if they failed to eat enough to supply the protein necessary for optimum growth.

Manchu and Midwest soybeans were again compared in this experiment. Both varieties were ground and mixed with the other feeds at the rate of 1 pound to every 6 pounds of corn. The pigs receiving the ration containing Midwest soybeans ate more feed and made faster gains than those receiving the Manchu soybeans.

ONE PART OF SOYBEANS TO TWELVE OF CORN INSUFFICIENT

A ration containing only 1 pound of Manchu soybeans to every 12 pounds of corn was also tried. That this was too small an amount to balance the corn satisfactorily was indicated by the pigs, gaining only 86.2 percent as rapidly and requiring 14.3 percent more feed per unit of gain than did those fed the same variety at the rate of 1 pound of beans to every 6 pounds of corn.

OTHER PROTEIN FEEDS BENEFICIAL WITH SOYBEANS

For one group of pigs in the experiment cottonseed meal at the rate of 4.9 pounds in each 100 pounds of total feed was added to the ration containing Manchu soybeans and corn in the ratio of 1:6. In practical feeding, of course, rather than superimposing a protein supplement on a ration that is already balanced the supplement would be used to replace a part or all of the protein feed included in the original ration. However, for the purpose of increasing the rapidity of the gains without reducing the percentage of soybeans in the ration, the tentative plans of the 1929 cooperative soft-pork investigations, in which the experiment was to be included, called for the feeding of one group of pigs a basal ration of 6 parts of corn to 1 of soybeans with enough of some supplement, such as a dairy by-product, fish meal, or cottonseed meal, added to supply 2 percent of protein. Cottonseed meal was the supplement chosen.

The rapidity of the gains was increased 23.4 percent by the cottonseed meal. In spite of its higher cost a pound, due to the extra protein, the ration containing cottonseed meal resulted in less expensive gains than those made on the same ration without the cottonseed meal.

Whole cooked soybeans were compared with raw ground soybeans in the same experiment, but this part of the test will be referred to later.

The pigs were shipped to Pittsburgh at the close of the experiment and were slaughtered by the Pittsburgh Provision Company. Dr. H. K. Walter, who served as a member of the grading committee in the cooperative soft-pork investigations for a period of six years, graded the carcasses for firmness. The grading was done 40 hours after slaughter and with the temperature of the cooler at 36° F. The number of carcasses falling in each classification of firmness is shown at the foot of Table 12.

COOKED SOYBEANS AN EFFECTIVE PROTEIN SUPPLEMENT

As previously shown, even when minerals were fed, corn and soybeans failed to make an effective ration for the feeding of pigs having no forage, particularly when they were carried from an initial weight of 40 or 50 pounds to a final one of 175 pounds or more. Experiments conducted to study the effect of cooking on the palatability and feeding value of soybeans are reported in Table 13. The soybeans were boiled over a gas burner until they were thoroly cooked. It was found that the time required for cooking could be shortened somewhat by soaking them over night.

The cooked soybeans were compared with raw ground soybeans and with tankage for supplementing corn and minerals, or corn, minerals, and ground alfalfa. They were fed at the rate of 0.7 pound daily a head thruout two of the experiments and at the rates of 0.6 and 0.8 pound, respectively, before and after the pigs averaged 100 pounds in weight, in the other experiment. In determining the amounts to feed, the beans were weighed before cooking.

TABLE 13.—Comparison of Raw Soybeans, Cooked Soybeans, and Tankage for Pigs in Dry Lot

	Corn Raw soybeans Minerals	Corn Cooked soybeans Minerals	Corn Tankage Minerals
Number of experiments	3	3	3
Number of pigs	20	20	20
Initial weight per pig, pounds	53.19	53.3	52.9
Final weight per pig, pounds	198.87	205.9	206.5
Average daily gain, pounds	.79	1.22	1.05
Days required to gain 150 lb.	190	123	143
Daily feed per pig: (pounds)			
Corn	3.00	3.49	3.82
Supplement	.61	.70	.32
Ground alfalfa	.04	.05	.05
Minerals	.11	.11	.04
Total	3.76	4.35	4.23
Feed per 100 lb. gain: (pounds)			
Corn	381.12	285.04	363.62
Supplement	77.73	57.16	31.09
Ground alfalfa	5.31	4.07	4.66
Minerals	13.34	8.72	3.97
Total	477.50	354.99	403.34
Cost of feed per 100 lb. gain	$8.50	$6.80	$7.21
Replacement value of soybeans per bu.	.59	2.53	.....

Corn 84¢, soybeans $1.50 a bu.; tankage $80, ground alfalfa $30, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.; cooking soybeans 1¢ a lb.

Altho mixed with corn the raw ground soybeans, the tankage, and the minerals were fed on a basis of a given quantity daily a head in one experiment. In the other two experiments a definite percentage of beans was mixed with the corn and this percentage reduced when the pigs averaged 100 to 125 pounds. A summary of the three experiments shows that the ground soybeans fed averaged 1 pound for every 4.9 pounds of corn, while the cooked soybeans averaged 1 pound to every 5 pounds of corn. As much total feed as the pigs would clean up twice daily was fed in each experiment.

Cooking increased the rate of growth 0.43 pound daily a head and enabled the pigs to reach a market weight of 200 pounds 68 days earlier than those getting the raw beans. Only 74 percent as much feed per unit of gain was required by the pigs getting the cooked beans as by those getting the raw beans.

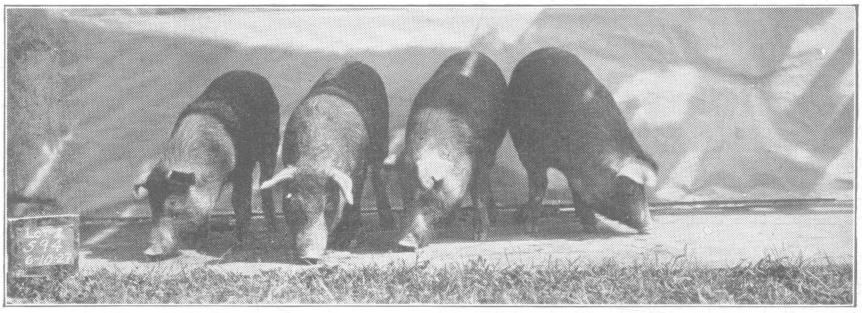


Fig. 6.—Ration: Corn, ground soybeans, ground alfalfa, and minerals

Initial weight per pig, 48.5 lb.
Average daily gain for 24 weeks, 0.53 lb.

Pigs confined indoors during the experiment

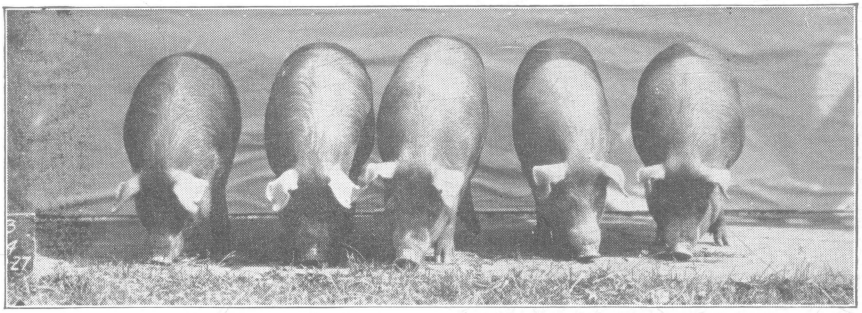


Fig. 7.—Ration: Corn, cooked soybeans, ground alfalfa, and minerals

Initial weight per pig, 49.0 lb.
Average daily gain for 24 weeks, 1.19 lb.

Pigs confined indoors during the experiment

Without exception, when minerals were fed, cooked soybeans also produced faster gains and greater gains from a given amount of feed than did tankage. With other feeds at the prices used, and without taking the difference in the rapidity of gains into account, the ground raw soybeans were worth $0.59 a bushel and the cooked beans $2.53, or $1.94 more a bushel than the raw ones.

TABLE 14.—Comparison of Raw Soybeans, Cooked Soybeans, and Tankage for Pigs on Rape Pasture

	Corn **Raw soybeans** Minerals	Corn **Cooked soybeans** Minerals	Corn **Tankage** Minerals
Number of experiments	3	3	3
Number of pigs	26	26	26
Initial weight per pig, pounds	56.1	56.3	56.5
Final weight per pig, pounds	205.9	209.3	205.3
Average daily gain, pounds	**1.23**	**1.42**	**1.36**
Days required to gain 150 lb.	122	105	110
Daily feed per pig: (pounds)			
Corn	4.34	4.57	4.69
Supplement	.56	.58	.31
Minerals*	.08	.08	.07
Total concentrates	**4.98**	**5.23**	**5.07**
Feed per 100 lb. gain: (pounds)			
Corn	352.36	320.54	344.13
Supplement	45.32	40.81	22.56
Minerals	6.75	5.64	5.21
Total concentrates	**404.43**	**366.99**	**371.90**
Cost of feed per 100 lb. gain†	$6.97	$6.67	$6.51
Replacement value of soybeans per bu.	.98	1.89	.....

*No minerals other than salt were fed in the first experiment.
†Not including pasture.
Corn 84¢, soybeans $1.50 a bu.; tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.; cooking soybeans 1¢ a lb.

Raw soybeans, cooked soybeans, and tankage were likewise compared as supplements to corn in three experiments with pigs on pasture, Table 14. As in dry-lot feeding, cooked soybeans proved superior to either raw beans or tankage. With tankage figured at $80 a ton the ground soybeans and cooked soybeans showed comparative feeding values of $0.98 and $1.89 a bushel, respectively. Besides a sufficient saving in feed per unit of gain to make a difference in value of $0.91 a bushel, the cooking of the beans enabled the pigs to reach a market weight of 200 pounds 16 days earlier.

DIGESTIBILITY OF SOYBEANS INCREASED BY COOKING

That the cooked soybeans were more palatable than the raw beans was indicated by the greater daily feed consumption. To determine whether the better showing made by the pigs fed the cooked beans was due merely to the larger amount of feed consumed or whether there was an actual increase in the digestibility or

nutritive value of the cooked beans, a second group of pigs was fed cooked beans in one experiment, Table 15. One group was given all the total feed they would consume, while the other group was limited to the same quantity of feed that was consumed by the pigs getting the raw beans.

TABLE 15.—Does Cooking Soybeans Increase Their Nutritive Value?

Experiment started Nov. 1, 1927	Corn **Ground soybeans** Ground alfalfa Minerals	Corn* **Cooked soybeans** Ground alfalfa Minerals	Corn **Cooked soybeans** Ground alfalfa Minerals	Corn **Tankage** Ground alfalfa Minerals
Number of pigs	7	7	7	7
Number of days on feed	210	210	133	168
Initial weight per pig, pounds	44.62	44.79	44.71	44.45
Final weight per pig, pounds	198.07	246.93	213.43	217.21
Average daily gain, pounds	**.73**	**.96**	**1.27**	**1.03**
Days required to gain 155 lb	212	161	122	151
Daily feed per pig: (pounds)				
Corn	2.75	2.76	3.27	3.58
Supplement	.56	.55	.71	.30
Ground alfalfa	.11	.11	.13	.12
Minerals	.09	.09	.11	.06
Total	**3.51**	**3.51**	**4.22**	**4.06**
Feed per 100 lb. gain: (pounds)				
Corn	376.99	286.79	258.08	348.24
Supplement	76.96	56.62	55.60	28.92
Ground alfalfa	14.41	11.71	10.53	11.85
Minerals	12.01	9.55	8.59	5.92
Total	**480.37**	**364.66**	**332.80**	**394.93**
Cost of feed per 100 lb. gain	$8.98	$7.28	$6.71	$7.47
Replacement value of soybeans per bu.	.42	2.19	2.77	.....

*Total feed allowance limited to the amount taken by the group fed ground soybeans. The other three groups were full-fed twice daily.

Corn 84¢, soybeans $1.50 a bu.; tankage $80, ground alfalfa $30, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.; cooking soybeans 1¢ a lb.

After 30 weeks of feeding, the pigs that received the raw beans averaged 198 pounds in weight, while those receiving the cooked beans, and exactly the same amount of total feed, averaged 247 pounds. Cooking, besides producing much faster growth, resulted in a saving of 115.7 pounds of feed for each 100 pounds of gain.

In the same experiment, the pigs fed 0.71 pound of cooked soybeans daily a head as a supplement and allowed all the other feed they would eat readily twice daily were ready for market 84 days earlier than those fed the raw beans. Furthermore, they required 148 pounds less feed for each 100 pounds of gain. With other feeds at the prices used, the ground raw beans showed a replacement value of $0.42 a bushel; the cooked soybeans $2.19 a bushel when the total amount of feed was the same, and $2.77 a bushel when a full feed was allowed.

By growing soybeans and cooking them one can provide pigs with a highly effective ration made up almost exclusively of feeds grown on the farm. Heretofore, this has been considered possible only when dairy cows were kept and skimmilk or buttermilk was available for feeding. Such a plan of feeding should appeal particularly to the man who feels that he cannot afford to buy protein concentrates for his hogs. It would be necessary to purchase minerals but these represent only a small percentage of the ration. If minerals like those used in the experiments herein reported were bought separately and mixed; their cost would be so low that it would certainly not often be prohibitive. For winter feeding a little green, leafy, ground leguminous hay in the ration would also be beneficial, but the hay could likewise be grown rather than purchased. Altho cooked soybeans, from the standpoint of production, are highly commendable, the danger of producing soft pork is an objection to their general adoption as a protein concentrate for growing and fattening pigs.

PROCESS OF MANUFACTURE AFFECTS WORTH OF SOYBEAN OILMEALS

The oil or fat in soybeans, which represents from 13 to 20 percent of their total weight, depending on the variety, soil, season, etc., is of a semi-drying character and is suitable for a number of commercial uses. Several mills in America now press the oil from soybeans. Upon the removal of a large portion of the oil the meal or residue has a considerably higher protein content per unit of weight than had the original beans.

Experiments with soybean oilmeals have shown a wide variation in their worth for supplementing corn for pigs. In a few instances soybean oilmeal gave no better results than ground soybeans. In others the soybean oilmeal used had a much higher value than soybeans and, with suitable minerals added, compared favorably with tankage even for dry-lot feeding.

To illustrate the wide variation in results obtained from different soybean oilmeals, experiments with pigs on rape pasture during the summers of 1919 and 1922 may be cited. In 1919 the pigs fed soybeans, soybean oilmeal, and tankage as supplements gained 1.38, 1.60, and 1.45 pounds daily a head, respectively, and as named consumed 398, 346, and 370 pounds of concentrates for each 100 pounds of gain. In the 1922 experiment the groups of pigs given the same feeds as supplements gained 1.13, 0.98, and 1.22 pounds daily a head and consumed 441, 461, and 394 pounds of concentrates for each 100

pounds of gain. In 1919 soybean oilmeal containing 49.25 percent of protein and 3.22 percent of fat or oil was used. The meal fed in 1922 analyzed 44.81 percent protein and 11.66 percent fat. Dry-lot experiments also showed a wide variation in the feeding values of soybean oilmeals.

Different methods are used in extracting the oil from soybeans. Hydraulic- or old-process soybean oilmeal is made in the same manner as old process linseed oilmeal. One step in this method of preparation consists of cooking the pulverized beans in a steam-jacketed cooker and subjecting them to a bath of live steam, which is applied directly by means of small steam jets.

In the manufacture of solvent or new-process meal, the oil is extracted by some chemical or solvent, such as benzol.

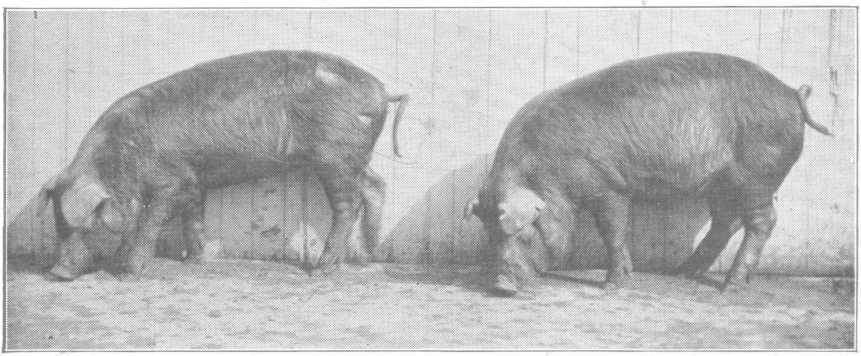


Fig. 8.—Both of these pigs were fed corn, expeller soybean oilmeal, and minerals.

The soybean oilmeal used in the ration fed the pig at the left had a raw, bean-like, disagreeable taste. From Dec. 11 to May 20 it gained at the rate of 0.5 lb. a day.

The soybean oilmeal used in the ration fed the pig at the right had a pleasing, nut-like, taste and odor. From Dec. 11 to May 20 it gained at the rate of 1.14 lb. a day.

A third method of removing the oil consists in passing the crushed beans thru a screw-type continuous press, known as an expeller. Whether the expeller meal has a disagreeable, raw, bean-like taste or a pleasing nut-like taste and aroma depends on the temperature developed while the oil is being expressed and this in turn depends to some extent upon the adjustment of the machine, but particularly on the dryness of the beans when pressed. The lower the moisture content of the beans the greater the friction developed and the higher the temperature. The beans as they are received by the mills usually contain 10 percent or more of moisture,

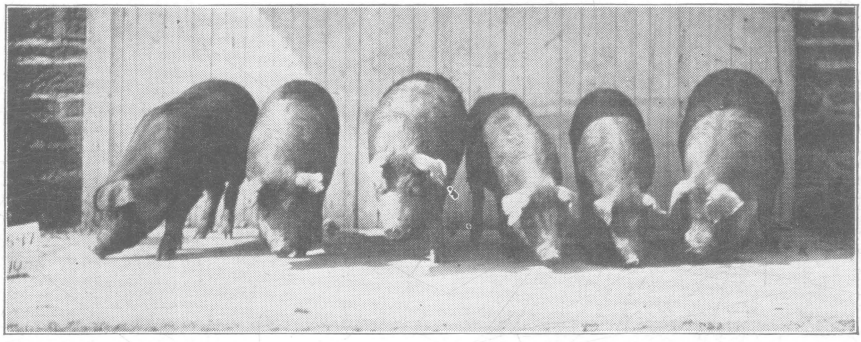


Fig. 9.—Corn, ground soybeans, and minerals
Average daily gain, Dec. 11 to May 27, 0.81 lb.

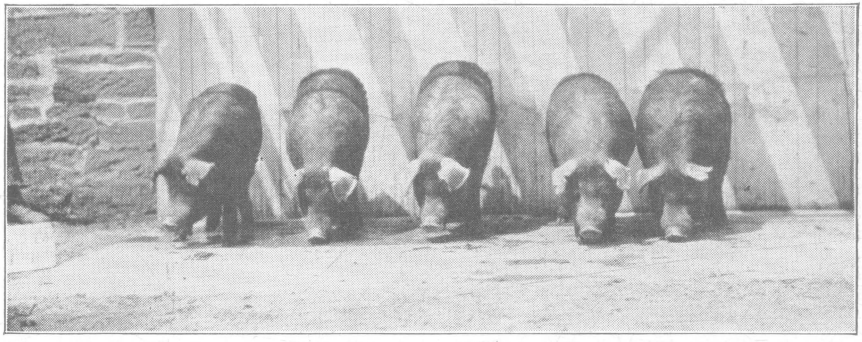


Fig. 10.—Corn, solvent soybean oilmeal, and minerals
Average daily gain, Dec. 11 to May 27, 0.77 lb.

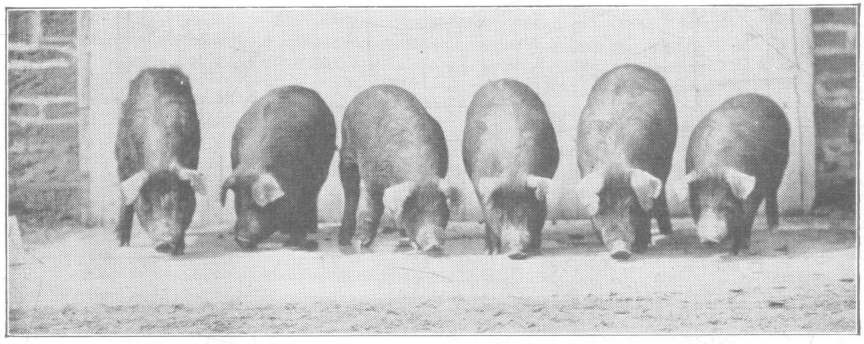


Fig. 11.—Corn, hydraulic soybean oilmeal, and minerals
Average daily gain, Dec. 11 to May 27, 0.91 lb.

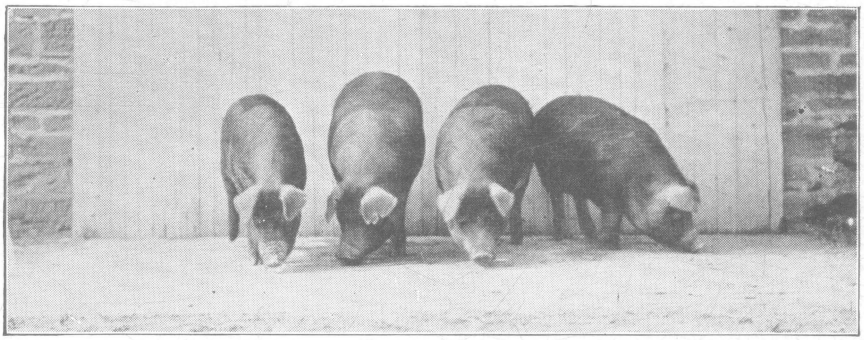


Fig. 12.—Corn, raw-tasting expeller soybean oilmeal, and minerals
Average daily gain, Dec. 11 to May 27, 0.79 lb.

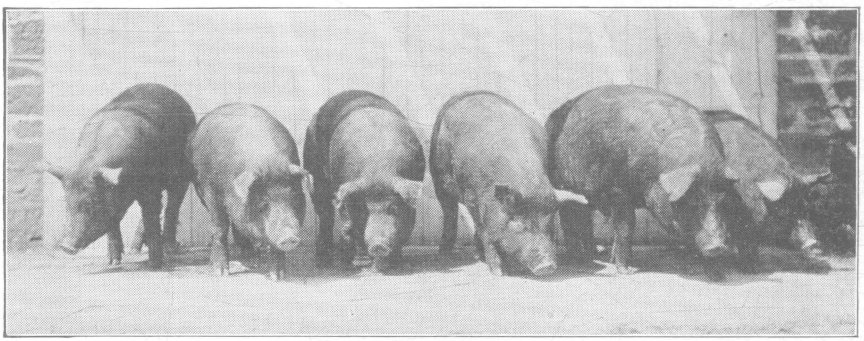


Fig. 13.—Corn, nut-like expeller soybean oilmeal, and minerals
Average daily gain, Dec. 11 to May 27, 1.13 lb.

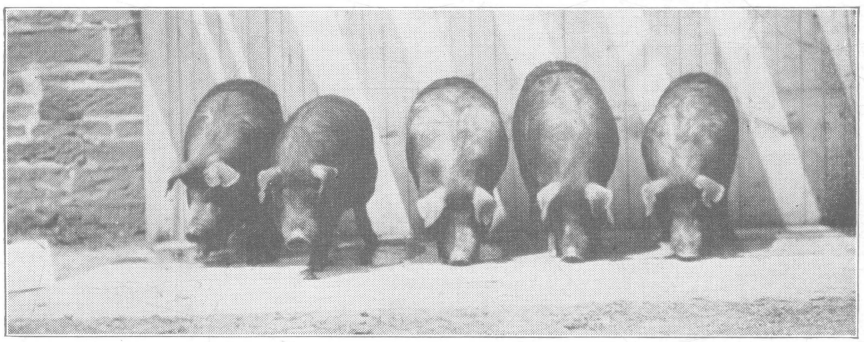


Fig. 14.—Corn, tankage, and minerals
Average daily gain, Dec. 11 to May 27, 1.13 lb.

and to make a desirable meal they should first be passed thru a dryer to reduce their moisture content. If pressed without predrying it is difficult to make a meal having a low oil content. By first reducing the moisture to around 4 percent a meal having an oil content of 4 to 6 percent can be produced. A large share of the soybean oilmeal now made in America is of the expeller type. Usually, too, the necessary procedure required to produce a meal of good quality and to give a high yield of oil, is now understood by the manufacturer.

Because of the marked difference in the results secured in some of the earlier trials with soybean oilmeals from different sources, experiments were conducted to determine the relative feeding values of solvent, hydraulic, raw-tasting expeller, and nut-like expeller soybean oilmeals.

The composition of the meals used in these experiments, as determined by the Nutrition Section of the Department of Animal Industry, is given in Table 16. For comparison the average composition of the soybeans used in two of the tests is also presented.

TABLE 16.—Analyses of Soybeans and Soybean Oilmeals Used in Experiments Reported in Table 17

	Water	Ash	Crude protein	Carbohydrates		Ether extract*
				Fiber	Nitrogen-free extract	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soybeans	6.77	4.73	38.25	4.73	28.51	17.01
Solvent soybean oilmeal	7.05	9.80	45.00	5.57	30.93	1.65
Hydraulic soybean oilmeal	7.67	5.56	45.50	4.80	30.22	6.25
Raw-tasting expeller soybean oilmeal	6.06	6.03	44.81	6.05	25.39	11.66
Nut-like expeller soybean oilmeal	6.74	4.57	50.87	4.96	26.95	5.91

*Oil or fat.

In one comparison of the different meals the corn, protein supplement, and mineral mixture were self-fed, separately. In another, which was made at the same time, the feeds were mixed and hand-fed. Several of the pigs that received their feeds self-fed separately became crampy or lame before the close of the experiment. On the other hand, no cases of lameness occurred among the hand-fed pigs, which were given a larger proportion of minerals than was consumed by the self-fed pigs. This, together with their somewhat slower growth, seemed to prevent the development of lameness.

Other tests have shown that rapidly growing pigs receiving rations deficient in minerals and vitamins are more likely to become crampy or lame than are pigs that gain more slowly. Apparently, pigs cannot be depended upon to take a sufficient amount of minerals to meet their needs if the mineral mixture is self-fed separately. During the experiments the pigs were confined indoors in small pens having concrete floors. If a ration is defective in any way it

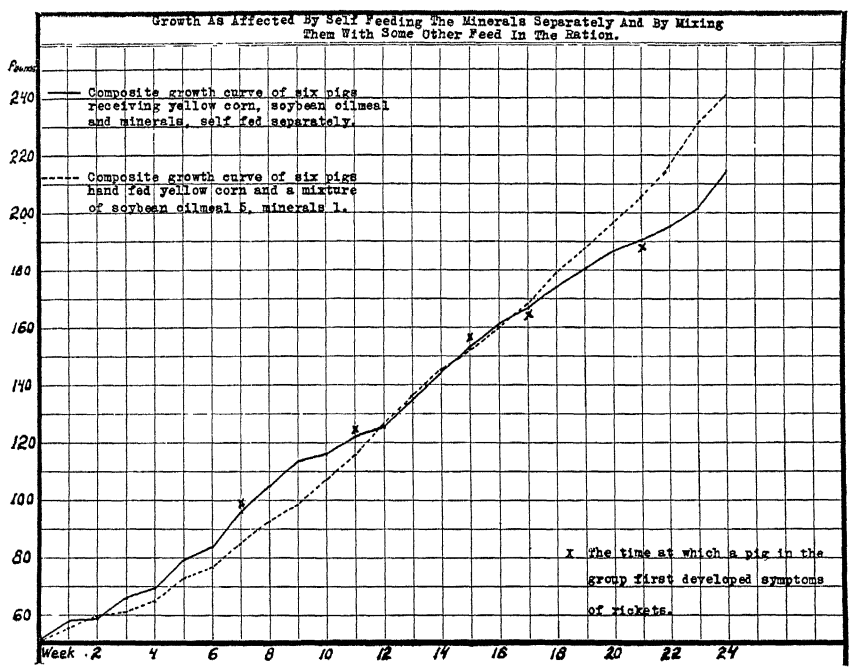


Chart 1.—Composite growth curves of pigs self-fed separately and hand-fed. Both lots were confined indoors. Self-feeding normally produces somewhat faster gains than hand-feeding, but because of the crampiness occurring among the self-fed pigs the hand-fed pigs averaged 24 pounds heavier at the close of the experiment.

is revealed more quickly under such conditions than if the pigs are allowed to run outdoors in the sunshine, the ultra-violet rays of which aid in the assimilation of the minerals. The anti-rachitic vitamin serves the same purpose. The rations fed were probably deficient in this factor, and, if so, could have been improved by the addition of a little ground alfalfa, which is comparatively rich in anti-rachitic properties.

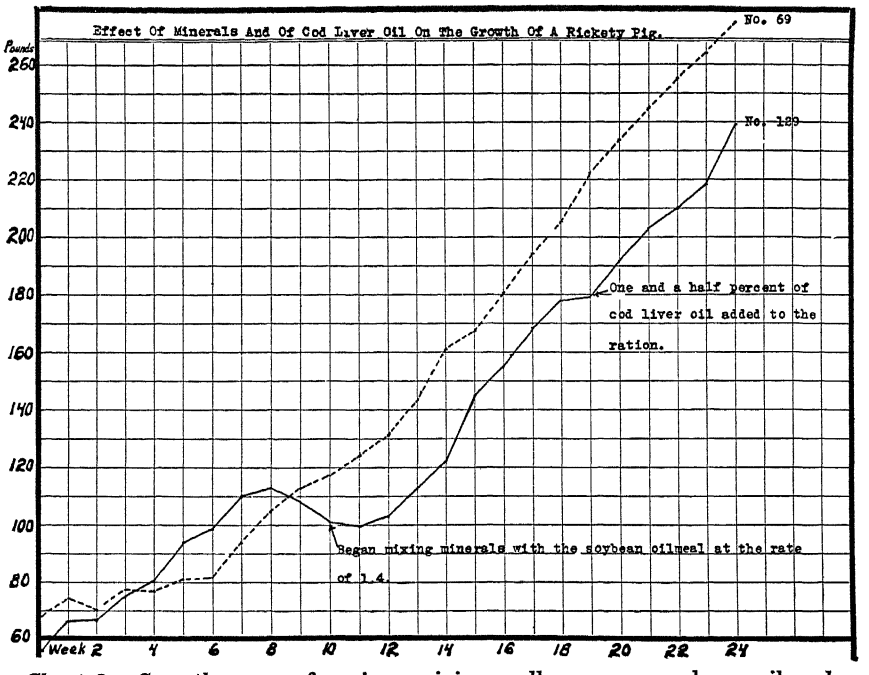


Chart 2.—Growth curve of a pig receiving yellow corn, soybean oilmeal, and minerals, self-fed separately, which became stiff and crampy after seven weeks. Compared with growth curve of its only original pen mate which did not become lame. Minerals, the antirachitic vitamin, and the rapidity of growth all influence the development or prevention of rickets in pigs kept in confinement.

In the third experiment, which was also conducted indoors, the feeds were mixed and self-fed, but no crampiness occurred among the pigs. Table 17 gives the average results of the three comparisons.

The average of the three tests shows that the nut-like expeller meal, the hydraulic meal, the solvent meal, and the raw-tasting expeller meal ranked in the order named so far as their effect on the rate of growth and the growth from a given quantity of feed were concerned. Both the raw-tasting expeller and the solvent meals proved to be unsatisfactory supplements. In two of the three comparisons the nut-like expeller meal produced more gain in live weight from a given quantity of feed than did tankage. If four of the six pigs that received minerals self-fed free-choice had not become crampy or lame the expeller soybean oilmeal would probably have been a more effective supplement than tankage in the other experiment as well.

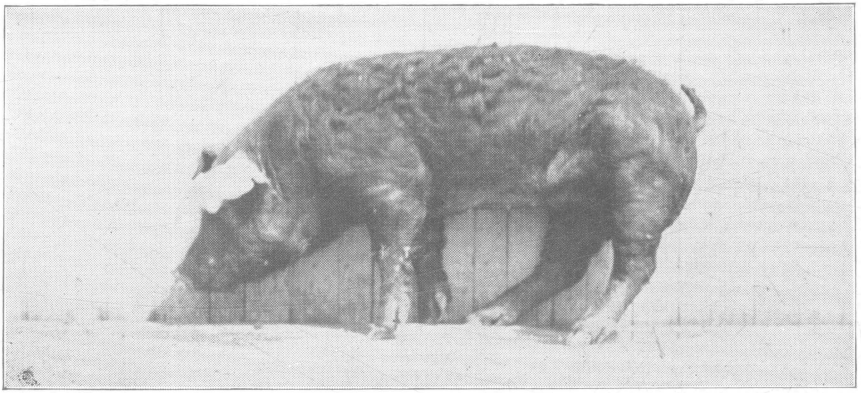


Fig. 15.—Pig suffering from rickets as a result of failing to take sufficient minerals when these were kept before it in a self-feeder. The ration consisted of yellow corn, soybean oilmeal, and minerals, self-fed, separately. The pig was confined indoors.

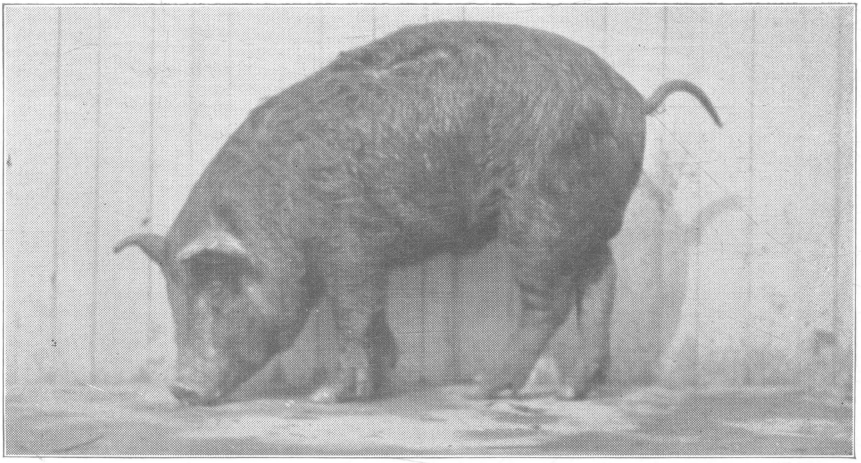


Fig. 16.—Another rickety pig, originally from the same group, after having received a teaspoonful of cod-liver oil in each feed for ten days. If the disease is not too far advanced the administration of cod-liver oil frequently brings about a marked improvement in a surprisingly short time.

The hydraulic soybean oilmeal was a fairly satisfactory supplement but was not equal to the nut-like expeller meal in feeding value. A fourth comparison of the two meals, in which both were manufactured from Manchu soybeans, gave similar results.

TABLE 17.—Summary of Experiments Comparing Different Types of Soybean Oilmeals

	Corn Ground soybeans Minerals	Corn Solvent soybean oilmeal Minerals	Corn Hydraulic soybean oilmeal Minerals	Corn Raw-tasting expeller soybean oilmeal Minerals	Corn Nut-like expeller soybean oilmeal Minerals	Corn Tankage Minerals
Number of experiments	3	3	3	3	3	3
Number of pigs*	20	20	20	20	20	20
Initial weight per pig, pounds	49.05	49.37	49.17	49.27	49.40	49.32
Final weight per pig, pounds	165.97	157.28	189.42	169.10	204.29	214.81
Average daily gain, pounds	**.65**	**.68**	**.86**	**.64**	**1.03**	**1.13**
Days required to gain 150 lb.	231	220	175	234	146	133
Daily feed per pig: (pounds)						
Corn	3.03	2.99	3.39	2.90	3.64	4.10
Supplement	.47	.48	.42	.42	.48	.43
Minerals	.08	.07	.08	.07	.09	.04
Total	**3.58**	**3.54**	**3.89**	**3.39**	**4.21**	**4.57**
Feed per 100 lb. gain: (pounds)						
Corn	465.81	438.82	394.92	452.60	354.68	364.41
Supplement	72.36	71.01	49.52	65.08	46.52	37.79
Minerals	12.07	10.67	8.88	11.02	8.66	3.82
Total	**550.24**	**520.50**	**453.32**	**528.70**	**409.86**	**406.02**
Cost of feed per 100 lb. gain	$9.61	$9.36	$ 7.98	$9.41	$ 7.24	$7.42
Replacement value per ton	—7.63	—5.19	37.25	—.13	67.51	.....

*During the experiments 4 pigs were removed from the lots receiving soybeans, 5 from the lots receiving the raw-tasting expeller soybean oilmeal, 3 from those receiving the nut-like expeller soybean oilmeal, and 2 each from the others.

Corn 84¢, soybeans $1.50 a bu.; soybean oilmeal $60, tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

GOOD QUALITY SOYBEAN OILMEAL AN EXCELLENT PROTEIN FEED

Table 18 gives the average results of four dry-lot experiments in which soybeans, soybean oilmeal, and tankage were compared as supplements to corn and minerals. Three percent of ground alfalfa was also included in the rations in two of the experiments.

Soybean oilmeal produced gains 44 percent more rapidly and on 15 percent less feed per unit of gain than did ground soybeans. As compared with tankage it made a favorable showing with respect to both the rate of growth and the gains produced from a given quantity of feed.

A summary of ten experiments comparing soybean oilmeal and tankage as protein supplements to corn for pigs in dry lot is reported in Table 19.

While the pigs given soybean oilmeal gained 3.3 percent slower than those given tankage they required 1.8 percent less feed per pound of gain produced. According to the average results of the ten trials soybean oilmeal was worth somewhat more per pound of protein contained than was tankage.

TABLE 18.—Soybean Oilmeal, Soybeans, and Tankage as Supplements to Corn for Pigs in Dry Lot

	Corn Ground soybeans Minerals*	Corn Soybean oilmeal Minerals*	Corn Tankage Minerals*
Number of experiments	4	4	4
Number of pigs	27†	27†	27†
Initial weight per pig, pounds	47.03	46.67	47.08
Final weight per pig, pounds	171.96	201.06	207.77
Average daily gain, pounds	.66	.96	.97
Days required to gain 150 lb.	226	157	155
Daily feed per pig: (pounds)			
Corn	2.53	3.28	3.44
Supplement	.48	.43	.30
Ground alfalfa	.05	.05	.05
Minerals	.08	.10	.04
Total	3.14	3.86	3.83
Feed per 100 lb. gain: (pounds)			
Corn	380.33	341.97	354.09
Supplement	72.99	44.77	31.05
Ground alfalfa	7.00	5.62	5.08
Minerals	12.51	10.35	4.51
Total	472.83	402.71	394.73
Cost of feed per 100 lb. gain	$8.37	$ 7.11	$7.07
Replacement value of soybeans a bu.	.52	.....	.....
Replacement value of soybean oilmeal a ton	.....	58.57	.....

*Three percent of ground alfalfa was also included in the rations in two of the experiments.

†During the experiments 3 pigs were removed from the lots receiving soybeans, 3 from those receiving tankage, and none from those receiving soybean oilmeal.

Corn 84¢, soybeans $1.50 a bu.; soybean oilmeal $60, tankage $80, ground alfalfa $30, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

Only one experiment was conducted in which soybean oilmeal was fed to pigs on forage when minerals were included in the ration. Rape pasture was used. The results of the experiment are reported in Table 20.

In this experiment soybean oilmeal produced gains 16 percent faster than ground soybeans and 5 percent faster than tankage. This enabled the pigs getting the soybean oilmeal to reach an average market weight of 200 pounds 16 days earlier than those getting soybeans and 5 days earlier than those getting tankage. The feed required per unit of gain did not differ greatly, but was 3.3 percent greater for the soybean group and 2.2 percent greater for the soybean oilmeal group than for the tankage group.

Soybean oilmeal, soybeans, and tankage, without minerals, were compared as supplements to corn for pigs on rape pasture in a

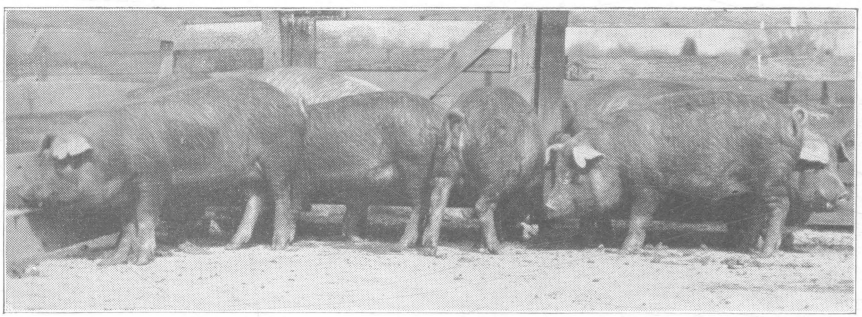


Fig. 17.—Corn, ground soybeans, and minerals; in dry lot
Average daily gain, Dec. 21 to Apr. 26, 0.82 lb.

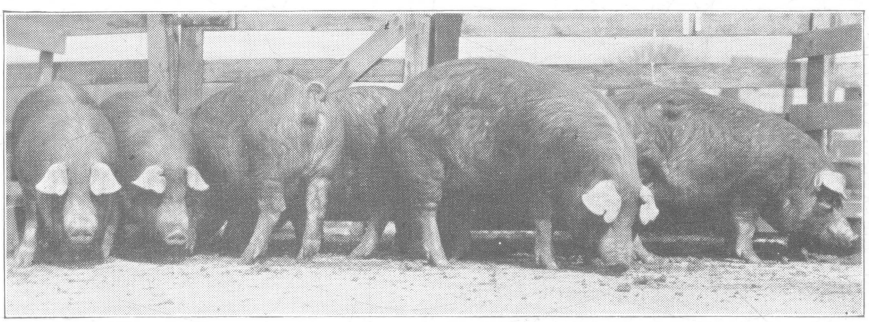


Fig. 18.—Corn, cooked soybeans, and minerals; in dry lot
Average daily gain, Dec. 21 to Apr. 26, 1.16 lb.

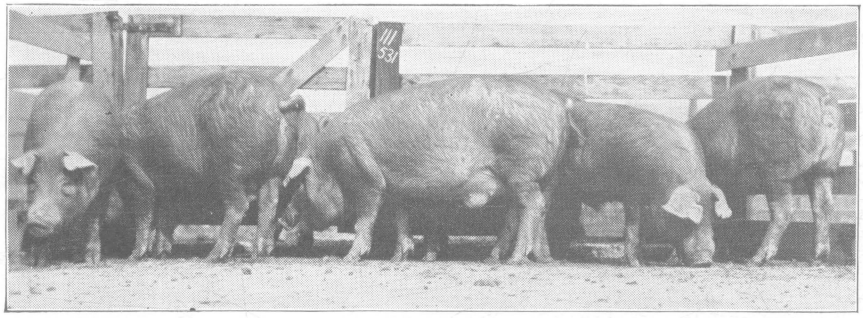


Fig. 19.—Corn, soybean oilmeal, and minerals; in dry lot
Average daily gain, Dec. 21 to Apr. 26, 0.96 lb.

Fig. 20.—Corn, tankage, and salt; in dry lot
Average daily gain, Dec. 21 to Apr. 26, 0.94 lb.

TABLE 19.—Summary of Experiments Comparing Soybean Oilmeal and Tankage as Supplements to Corn for Pigs in Dry Lot

	Corn Soybean oilmeal	Corn Tankage
Number of experiments	10	10
Number of pigs	69‡	69‡
Initial weight per pig, pounds	52.57	52.78
Final weight per pig, pounds	205.26	213.38
Average daily gain, pounds	1.08	1.12
Days required to gain 150 lb.	139	134
Daily feed per pig: (pounds)		
Corn	3.71	4.09
Supplement	.51	.39
Linseed meal*	.02	.03
Ground alfalfa†	.04	.05
Minerals	.10	.05
Total	4.38	4.61
Feed per 100 lb. gain: (pounds)		
Corn	343.45	367.35
Supplement	47.56	34.89
Linseed meal*	1.79	2.41
Ground alfalfa†	3.68	4.35
Minerals	9.45	4.60
Total	406.32	413.60
Cost of feed per 100 lb. gain	$ 7.22	$7.49
Replacement value per ton	71.79	.....

*A small quantity of linseed meal was fed along with both the soybean oilmeal and the tankage in one experiment.

†A little ground alfalfa was included in the rations in three experiments.

‡During the tests 4 pigs were removed from the lots receiving soybean oilmeal and 5 from those receiving tankage.

Corn 84¢ a bu.; soybean oilmeal $60, tankage $80, linseed meal $52, ground alfalfa $30, minerals $40 a ton; grinding corn 10¢ a 100 lb.

TABLE 20.—Soybean Oilmeal, Soybeans, and Tankage as Supplements to Corn for Pigs on Forage

Experiment started July 6, 1923	Corn Ground soybeans Minerals*	Corn Soybean oilmeal Minerals*	Corn Tankage Minerals*
Number of pigs	10†	10	10
Initial weight per pig, pounds	47.05	47.15	47.40
Final weight per pig, pounds	200.62	206.05	198.75
Average daily gain, pounds	1.31	1.51	1.44
Days required to gain 150 lb.	115	99	104
Daily feed per pig: (pounds)			
Corn	4.12	4.94	4.67
Supplement	.53	.40	.30
Minerals	.08	.08	.08
Total concentrates	4.73	5.42	5.05
Feed per 100 lb. gain: (pounds)			
Corn	315.76	326.75	324.02
Supplement	40.55	26.34	21.04
Minerals	6.01	5.29	5.55
Total concentrates	362.32	358.38	350.61
Cost of feed per 100 lb. gain‡	$6.25	$ 6.12	$6.14
Replacement value of soybeans per bu.	1.43	.....	.....
Replacement value of soybean oilmeal per ton	.....	60.98	.....

*Minerals consisted of equal parts of salt, limestone, and bone meal.

†A pig in the lot receiving soybeans died on Sept. 10 and another on Sept. 14.

‡Not including pasture.

Corn 84¢, soybeans $1.50 a bu.; soybean oilmeal $60, tankage $80, minerals $40 a ton; grinding corn 10¢, grinding soybeans 15¢ a 100 lb.

1919 experiment which is reported on page 178 of Bulletin 349. In that experiment the soybean oilmeal produced gains 17.6 percent faster than soybeans and 8.2 percent faster than tankage. Ten percent more feed per pound of gain was required by the group of pigs receiving soybeans and 1.6 percent more by the group receiving tankage than by the group receiving soybean oilmeal.

SOYBEANS MAY CAUSE SOFT PORK

Due to their high oil content, if soybeans, in sufficient quantities to supply the protein needed to balance corn, are fed from weaning time until the pigs are ready for market, they are likely to cause soft pork. This is true especially of pigs in dry lot, which require a higher percentage of protein in the ration than pigs on pasture. Soybean oilmeal, on the other hand, produces pork of a satisfactory degree of firmness.

Until a palatable variety of soybeans that is low in oil and high in protein can be produced, the plan of pressing the oil from the soybeans and feeding the meal rather than the beans offers the most logical solution to the soybean problem, so far as their effect on the firmness of the pork is concerned.

Morrison's feeding standard recommends that rations having nutritive ratios no wider than 1:5.6, 1:6.2, and 1:7 be fed to pigs in dry lot ranging from 50 to 100 pounds, from 100 to 150 pounds, and from 150 to 200 pounds in weight, respectively. To meet these standards it is necessary to feed pigs of the different weights, as named, approximately 1 pound of soybeans to every 3.7 pounds, 4.9 pounds, and 7.2 pounds of corn, respectively.

Some of the statements issued by the agencies cooperating in the soft-pork investigations[1] concerning the effect of soybeans and soybean oilmeal on the firmness of the pork are as follows:

> Soybeans fed as supplements to corn in dry lot in the ratio of 1 pound of soybeans to 3 pounds of shelled corn to pigs ranging up to 130 pounds in starting weights will not produce firm carcasses in the usual case when hogs are slaughtered after a gain of 100 pounds or more has been made on the corn-soybean ration.

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[1]The following institutions have participated in the cooperative study of the influence of soybeans and soybean oilmeal on the firmness of pork carcasses:

Alabama Agricultural Experiment Station, Arkansas Agricultural Experiment Station, Bureau of Animal Industry, U. S. Department of Agriculture, Kentucky Agricultural Experiment Station, Mississippi Agricultural Experiment Station, North Carolina Agricultural Experiment Station, Ohio Agricultural Experiment Station, Pennsylvania Agricultural Experiment Station, Purdue University Agricultural Experiment Station, South Carolina Agricultural Experiment Station, Tennessee Agricultural Experiment Station, and Virginia Agricultural Experiment Station.

Pigs with initial weights of 75 pounds or more, self-fed shelled corn and ground soybeans, with or without mineral mixtures, free-choice, on legume pasture, have produced carcasses of satisfactory firmness in the usual case when the rate of gain was 1.65 pounds or more per day for a period of 13 weeks.

Pigs with initial weights of 50 pounds or less, self-fed shelled corn and ground soybeans, with or without minerals, free-choice, on legume pasture have produced carcasses of unsatisfactory firmness in the usual case when the rate of gain was 1.40 pounds or less for a period of 15 weeks.

Pigs with initial weights between 50 and 75 pounds self-fed shelled corn and ground soybeans, with or without mineral mixture, free-choice, on legume pasture have produced carcasses varying widely in firmness when the rates of gain were between 1.40 and 1.65 pounds per day for a period of approximately 13 to 15 weeks.

Pigs with initial weights of 100 pounds or more and gaining at least 1⅓ pounds daily on a mixture of ground corn (9 or 12 parts) and ground soybeans (1 part) self-fed, with mineral mixture, free-choice, in dry lot, thru a period of approximately 9 weeks or longer have produced firm carcasses in the majority of cases.

Pigs with initial weights of 100 pounds or less and gaining a maximum of 1 pound daily on a mixture of ground corn (9 or 12 parts) and ground soybeans (1 part) self-fed with mineral mixture, free-choice, in dry lot, thru a period of 15 weeks or less have produced soft carcasses in the majority of cases.

Pigs with initial weights of approximately 40 to 70 pounds fed either raw or cooked soybeans, with corn and minerals in dry lot have produced carcasses of approximately the same degree of firmness at comparable finished weights.

Experiments have shown that corn oil, peanut oil, and soybean oil when present in the ration, either naturally contained or as added oil have a softening effect on the body fat which increases with increasing oil content in the ration.

FIRM PORK PRODUCED ON SOYBEAN OILMEAL

Pigs with initial weights ranging from 30 to 60 pounds were fed to a weight of approximately 100 pounds on rations composed of (1) corn and soybean oilmeal, (2) corn, soybean oilmeal, and alfalfa meal, and (3) corn, soybean oilmeal, alfalfa meal, and linseed meal, containing from 14.3 to 14.9 percent of soybean oilmeal. They were then fed to an average finished weight of approximately 215 pounds on the same mixture in each case modified to contain from 9.9 to 12.3 percent soybean oilmeal. Under these conditions firm carcasses were produced in the usual case. Supplementary minerals were fed with all of the rations. The soybean oilmeals fed varied from 5.7 to 7.5 percent in fat or oil content.

SUMMARY

Minerals are needed in the ration when soybeans or soybean oilmeal is used as the protein supplement.

Soybeans are not a satisfactory supplement to corn for weanling pigs which have no forage.

Soybeans have a higher feeding value when fed to pigs on pasture than when fed to pigs in dry lot, and are worth more for well-grown shotes than for younger pigs.

Varieties of soybeans differ in their palatableness and feeding value for pigs.

Whole soybeans were fully as effective as ground soybeans when they were self-fed free-choice. Grinding the soybeans permits mixing them with other feeds and thus forcing the pigs to take a sufficient quantity to balance the ration when they prove distasteful.

In the experiments reported, cooked soybeans were worth $1.94 a bushel more than ground soybeans for pigs in dry lot and $0.91 more for pigs on pasture. Furthermore, the pigs fed the cooked beans were ready for market 68 days earlier in the dry-lot trials and 16 days earlier in the pasture trials than were those fed the ground soybeans.

As shown by faster gains, on the same feed intake, and a lower feed requirement per unit of gain, cooked soybeans were more digestible than were the raw beans.

Soybean oilmeals differ in their feeding value depending on the method of manufacture.

Soybean oilmeal was superior to ground soybeans for supplementing corn.

Good quality soybean oilmeal was worth more per unit of protein contained than was 60-percent protein, steam-rendered, digester tankage.

Soybean oil when present in the ration, either naturally contained or as added oil, has a softening effect on the body fat, which increases with an increase in the oil content of the ration.

Soybeans, due to their high oil content, fed to pigs from weaning time until they are ready for market, in sufficient quantities to supply the protein needed to balance corn or other grains, are likely to cause soft pork.

Rapidity of growth is an important factor in producing firm carcasses when what might be termed "border-line" rations, or those containing a medium amount of softening oils, are fed. Hogs making slow gains on such rations usually produce less satisfactory carcasses than those making rapid gains.

Other factors influencing the firmness of the carcasses when softening feeds are used are the weight of the pigs at the beginning of the feeding period, or the length of time such feeds are fed, and the proportion of hardening to softening feeds used in the ration.

Pigs fed raw soybeans and cooked soybeans have had approximately the same degree of firmness at the same finished weights. As already mentioned, an increase in the rapidity of the gains tends to produce firmer carcasses. Aside from this, cooking the beans apparently has no influence on hardening the fat.

Soybean oilmeal can be fed without danger of producing soft pork.

Until a variety of soybeans that is low in oil, high in protein, and palatable to pigs can be found, probably the most satisfactory solution to the soybean problem so far as their effect on the firmness of the pork is concerned, is the plan of first pressing the oil from the beans and then feeding the meal rather than the beans themselves.